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Home Polysomnography in Children – a Complementary Assessment Method of Sleep Disorders in Children

Ambulante Polysomnografie im Kindesalter – eine ergänzende Methode zur Untersuchung von Schlafstörungen im Kindesalter

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Summary

Question of the study Laboratory polysomnography is considered to be the gold standard in the assessment of sleep disorders. However, for children the sleep laboratory is likely to be a sleep-disruptive setting requiring adaptation time. We addressed the question of whether there is a significant difference between principal sleep variables measured by home polysomnography without adaptation time and those measured by laboratory polysomnography with adaptation time. We endeavoured to find out whether home polysomnography might be an appropriate method for assessing sleep disorders in children.
Methods Twenty-five children, aged between 8.1 and 12.3 years and suffering from various sleep disorders, underwent ambulant polysomnography at home without adaptation time following laboratory polysomnography that incorporated a whole-day adaptation time.
Results Sleep architecture for non-REM and REM variables did not significantly differ between the two assessments. Indications of a more natural assessment of children's sleep habits were a reduced sleep latency, a higher sleep efficiency and a longer total sleep time during ambulant assessment. The acceptance of the ambulant assessment by children and parents was high, and the technical quality of the recording was good.
Conclusions Ambulant polysomnography might be a promising method for assessing sleep disorders in children as the feasibility is high and a reduction of the first-night effect is probable.

Keywords ambulant polysomnography – laboratory polysomnography – first-night effect – sleep architecture – sleep environment – sleep habits – children's sleep.

Zusammenfassung

Fragestellung Stationäre Schlaflaboruntersuchungen können als die differenzierteste apparative Methode zur Untersuchung von Schlafstörungen betrachtet werden. Im Kindesalter kann es allerdings bedingt durch die ungewohnte Schlafumgebung zu Beeinträchtigungen der Untersuchungsqualität kommen, so dass eine ausgedehnte Eingewöhnungszeit des Kindes an die Umgebung des Schlaflabors notwendig ist.
In der vorliegenden Untersuchung gingen wir der Fragestellung nach, ob eine ambulante Schlaflaboruntersuchung ohne Eingewöhnungszeit zuhause zu vergleichbaren Ergebnissen schlafarchitekturbezogener Variablen führt im Vergleich mit einer stationären Untersuchung.
Methodik 25 Kinder im Alter von 8,1–12,3 Jahren, die an unterschiedlichen Schlafstörungen litten, wurden zunächst einer stationären Schlaflaboruntersuchung mit einem Tag Eingewöhnungszeit unterzogen und nachfolgend nochmals einer Nacht einer ambulanten Untersuchung in ihrer gewohnten Schlafumgebung ohne Eingewöhnungszeit.
Ergebnisse Die Schlafarchitektur für Variablen des non-REM- sowie REM-Schlafs unterschiedet sich nicht signifikant voneinander zwischen den beiden Untersuchungsmethoden. Zudem erwies sich die technische Durchführbarkeit als praktikabel.

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Schlussfolgerungen Wir werten dies als Indikatoren dafür, dass eine ambulante Schlaflaboruntersuchung zumindest eine wertvolle Ergänzung der stationären Diagnostik von Schlafstörungen im Kindesalter darstellen könnte bei ausgewählten Indikationen.

Schlüsselwörter Ambulante Polysomnografie – First-Night-Effect – Schlafarchitektur – Schlafumgebung – Schlafgewohnheiten – kindlicher Schlaf.

Introduction

Laboratory polysomnography is considered to be the gold standard in the assessment of sleep disorders. However, especially for children, the sleep laboratory is likely to be a particularly sleep-disruptive setting requiring some adaptation time to eliminate first-night effects. In contrast, this problem does not seem to arise with home polysomnography in adolescent or preadolescent children [5, 7]. Ambulant assessment might therefore become a more appropriate way to assess sleep disorders in children. We addressed the question of whether principal sleep variables measured by home polysomnography without adaptation time and by laboratory polysomnography with adaptation time significantly differ from each other. We also tried to find out whether home polysomnography might be an appropriate method for assessing sleep disorders in children.

Methods

Twenty-five children (mean age: 10.31 years ± 2.29; age range: 8.1–12.3 years; 22 boys, 3 girls) participated in the study. All participants were in the prepubertal stage (Tanner stage 1). The children were recruited from the outpatient clinic of a sleep disorders unit in the Paediatric and Child Psychiatric Department of the University of Cologne. The purpose of their presentation to the clinic consisted in the assessment of various sleep disorders.

Fifteen children suffered from sleep–wake rhythm disorder and/or parasomnias, and four children suffered from narcolepsy or idiopathic central hypersomnia. In five children, sleep disorders could be excluded. Diagnoses were established on anamnesis, clinical interview and on polysomnography. Diagnoses corresponded with those of the International Classification of Sleep Disorders (ICSD) [9]. Fifteen children presented with the comorbid psychiatric diagnosis of attention deficit hyperactivity disorder (ICD 10 F 90.0 or 90.1) [2].

The environmental test conditions and the schedule of activities during the study were identical for all participants. Ambulant and laboratory polysomnography took place on weekends.

The same sleep recording assessment system was used for both procedures. Subjects who came to the sleep laboratory were recorded polysomnographically after spending the whole day in the clinic and becoming familiar with the sleep laboratory. Each subject slept alone in a sound-attenuated bedroom. Patients were studied during their habitual sleep times.

At least 24 hours following sleep laboratory assessment, a single night's ambulant recording was obtained for each child sleeping at home. Parents cooperated to ensure that no significant alteration to the child's usual day- or night-time routine occurred. A specially trained nurse arrived at the subject's home 2 hours before bedtime. The recordist explained the procedure to the parents and to the child and any questions were answered. Silver chloride electrodes, applied with collodion to the scalp and self-adhesive disposable electrodes to the face, were used to record one electroencephalogram (EEG) channel (C4-A1), two channels of eye movements (EOG) recorded from the outer canthus of both eyes referring to A2, and bipolar submental electromyography (EMG). Cardiorespirography with oxygen saturation, nasal flow and respiration was performed but not analysed for the purpose of this study.

When the electrodes were in place, electrode impedances were tested and signal quality was checked. Parents were given instructions to stop and reinitiate the recording if the child left his or her bed during the night. Moreover, they were instructed to remove the electrodes the next morning. The recording was terminated when the child spontaneously woke up the next morning.

Sleep stages were scored visually in 30-s epochs according to the criteria of *Rechtschaffen* and *Kales* [8]. Data analyses were performed for variables measuring principal sleep parameters and the sleep architecture of the participants. Mean values and standard deviations were calculated. The *t*-test was used to analyse possible differences in the main sleep polysomnographic values from the two assessments.

Results

Table 1 shows descriptive and statistical results for the principal sleep parameters in both assessments. Time in bed (TIB), total sleep time (TST), sleep period time (SPT), time spent awake (WAKE), and time awake after sleep onset (WASO) were significantly longer during ambulant polysomnography. Moreover, the Sleep Efficiency Index (SEI) was higher. In contrast, sleep onset latency (SOL) was higher during laboratory polysomnography.

In terms of sleep architecture, significant differences were detected for all absolute values concerning non-REM 1–4 sleep and REM sleep, being significantly higher during ambulant polysomnography. In contrast, when comparing the values of these variables with total sleep time, only minor, non-significant differences occurred.

Discussion

The results of our study indicate that sleep architecture does not differ significantly between ambulant and laboratory polysomnography. Differences can be observed in absolute but not in relative values for non-REM and REM sleep. According to our results, home polysomnography is probably an adequate method for assessing sleep disorders in children and minimizing the first-night effect. A higher sleep efficiency, a longer total sleep time, and a reduced sleep onset latency in comparison with laboratory polysomnography support this hypothesis. Reports from other studies indicate that the sleep environment, and not factors associated with sleep-disturbing aspects of the recording technique, is the critical determinant in the process of adaptation [1]. In

Table 1. Principal sleep variables comparing ambulant (A) and laboratory polysomnography (L).

Variable	Mean	SD	T	Significance (*t* -test)
Time in bed (TIB) (min)	422.16 L 604.31 A	45.18 151.14	23.0	0.0003
Total sleep time (TST) (min)	359.72 L 548.75 A	53.59 70.34	1.0	0.0000
Sleep period time (SPT) (min)	379.25 L 570.06 A	47.69 69.65	0.0000	0.0000
Wake after sleep onset (WASO) (min)	19.27 L 42.10 A	24.35 99.55	131.5	0.59
Wake time (WAKE) (min)	56.06 L 75.14 A	49.35 56.45	100.5	0.15
Non-REM 1 (min)	30.58 L 37.24 A	20.13 21.88	104.0	0.18
Non-REM 1 (%)	9.35 L 6.79 A	8.06 3.77	94.0	0.1
Non-REM 2 (min)	131.2 L 216.79 A	44.84 52.44	12.0	0.0000
Non-REM 2 (%)	35.9 L 39.35 A	9.7 6.69	107.0	0.21
Non-REM 3 (min)	49.43 L 90.60 A	17.08 32.62	13.0	0.0000
Non-REM 3 (%)	14.0 L 16.51 A	4.90 5.61	102.0	0.17
Non-REM 4 (min)	71.18 L 89.93 A	27.34 34.44	92.0	0.09
Non-REM 4 (%)	19.57 L 16.31 A	6.61 5.84	93.0	0.1
REM (min)	69.39 L 110.87 A	28.40 31.31	5.5	0.0000
REM (%)	20.38 L 20.40 A	7.67 5.74	146.0	0.90
REM Phases (*n*)	7.0 L 9.10 A	8.08 13.54	62.0	0.10
Number of sleep stage changes	48.81 L 59.95 A	17.18 23.98	49.5	0.01
Number of wake periods	4.8 L 5.5 A	2.3 6.3	84.5	0.44
Sleep onset latency (SOL) (min)	52.03 L 47.56 A	53.98 55.09	117.0	0.52
Sleep efficiency index (SEI) (%)	84.4 L 91.9 A	24.54 19.09	122.0	0.27

their study, *Norra* et al. [6] reported no differences in the sleep routine for subjects undergoing ambulant polysomnography.

On the other hand, we must admit that the results are ambiguous in some points as the time spent awake and the number of sleep stage changes were higher during ambulant polysomnography. Moreover, a possible influence of the sleep laboratory assessment preceding ambulant polysomnography as an adaptation night must be considered. So far, a final conclusion regarding our results is not yet possible.

There are only very few reports in the literature about home polysomnography in children. *Kahn* and *Heckmatt* [5] and *Palm* et al. [7] support our results as they could not find a first-night effect for home polysomnography in children and adolescents. Compared to the findings in the normative home polysomnography study of *Stores* et al. [10], we did not observe an extended degree of SWS and reduced stage 2 non-REM sleep. This observation might possibly be due to comorbid ADHD (attention deficit–hyperactivity disorder) diagnosis in the majority of the participants in our study. Similar characteristics of sleep architecture have been observed in this disorder [4]. Yet as with *Stores* et al. [10], we also found higher sleep efficiency and longer total sleep time during ambulant assessment.

Our experiences indicate that ambulant polysomnographic assessment in children is highly feasible. Almost no technical problems occurred, and the level of acceptance by the children and the parents was good. No child refused to take part. Moreover, the technical quality of the recording was sufficient to obtain valid analyses of the sleep architecture. Recording difficulties were minimal, and satisfactory recordings were obtained in all cases. Finally, ambulant sleep recordings might be less expensive than sleep laboratory assessment. *Golpe* et al. [3] performed an economic analysis and reported significantly lower costs for ambulant recordings.

Some serious restrictions in ambulant polysomnography have to be mentioned. The investigation of sleep disorders such as parasomnias and nocturnal seizures requires a high technical standard and continuous monitoring including videotaping. Moreover, the assessment of severe diseases,

especially sleep-related breathing disorders, might necessitate immediate medical intervention. Although ambulant polysomnography might become an important screening method in the assessment of sleep disorders, it cannot replace sleep laboratory functions.

Owing to the lack of standardized empirical data, ambulant polysomnography does not correspond with the official recommendations of the paediatric section of the German Sleep Society (DGSM) for the assessment of sleep disorders in children.

Conclusions

In summary, our study supports the hypothesis that home polysomnography might be a promising method for assessing sleep disorders in children. It might in future become an easy and economical screening procedure that takes into account the child's acceptance of technical assessment, reflects the real-life sleep situation at home and, finally, seems to reduce the adaptation time needed during laboratory polysomnography.

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